BIDIRECTIONAL BELT TENSIONING APPROACH

FIELD OF THE INVENTION

[0001] The invention relates to devices for varying tension in belts of a device according to operation of the device.

BACKGROUND AND SUMMARY

[0002] Various approaches have traditionally been taken in the design of belt drive systems to provide adequate belt tension, and therefore adequate drive torque capacity, throughout useful life of the drive. In a fixed-center drive approach, an initial tension is applied to the belt, and then the roller or pulley centers are fixed in place. In this arrangement, a large initial tension must be applied in anticipation of tension loss over the life of the drive. In a linear, live-center drive arrangement, one or both of the pulleys are linearly tensioned away from one another. In a backside/inside tension arrangement, such as that shown in FIG. 1, a drive pulley and a driven pulley 3 are drivingly connected via a belt 4. The drive pulley 2 receives motive power from a motor 5. One or more idler pulleys 6 is biased against the inside or the outside of the belt 4 to induce tension. An example of a biasing mechanism is a spring 7 between the idler pulley 6 and a frame 8 of the device in which the pulley system is used.

[0003] These approaches are subject to one or more of several obstacles or drawbacks Such drawbacks include mechanism complexity; unintended drive dynamics due to the live center arrangement and/or tensioner mechanism; accelerated component wear due to large belt loads and/or reverse bending of belts; uncompensated tension variation due to such factors as belt stretch, frame creep, component wear, component runout (including belt runout), and dimensional changes due to temperature or humidity variations.

[0004] Embodiments employ a new live center approach in which one pulley is tensioned away from the other or both of the pulleys are tensioned away from each other, but in a pivoting fashion, as opposed to the linear fashion of the prior art. This exploits the fact that the resultant belt load on the pulleys reorients when torque is applied to the system. Embodiments employ a geometry such that as torque is applied in a particular direction, belt tension increases proportionally without requiring an additional mechanism. Likewise, when torque is applied in a direction opposite to the particular direction, belt tension decreases proportionally. Thus, many of the drawbacks of prior art devices are overcome with embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a schematic representation of a prior art tensioner.

[0006] FIG. 2 is a schematic representation of a tensioner of embodiments.

[0007] FIG. 3 is a schematic representation of another tensioner of embodiments.

[0008] FIG. 4 is a schematic representation of another tensioner of embodiments.

[0009] FIG. 5 is a more general schematic representation of a tensioner of embodiments.

[0010] FIG. 6 is a general schematic representation of a tensioner of embodiments.

DESCRIPTION

[0011] For a general understanding of the present invention, reference is made to the drawings. In the drawings, like reference numerals have been used throughout to designate identical elements.

[0012] Embodiments comprise a live center belt tensioner 1 in which a first pulley 10, preferably a drive pulley, is biased away from a second pulley 11, preferably a driven pulley. The first and second pulleys 10, 11 are drivingly connected via a belt 12. The drive pulley 10 receives rotational motive power from a motor 13, which it

then transfers to the driven pulley 11 via the belt 12. The motor 13 is preferably mounted on a motor mount 14, such as a motor plate. The motor mount 14 has a freely pivotable connection 15 to a frame 16 of the device in which the tensioner is used. The driven pulley 11 is preferably connected to a rotating element 17 of the device. For example, in embodiments deployed in a marking device, the rotating element can be a print drum, a fuser roll, or the like, though other elements could be driven with the tensioner of embodiments.

[0013] Embodiments employ a first biasing mechanism 20 to bias the first pulley 10 away from the second pulley 11 in a pivoting fashion, thus placing tension in the belt 12. The first biasing mechanism 20 induces a biasing moment M_{bias} such as, for example, upon the motor plate, about the pivot point or connection 15. For example, in embodiments, a linear spring 21 can be attached to the motor mount 14 and to the frame 16 of the device. Preferably, the linear spring 21 would have a preload to place tension on the belt and would be mounted a distance d_{bias} from the pivot point to provide an initial $M_{bias} = d_{bias} \times F_{bias}$ about the pivot point 15, where F_{bias} initially is the preload of the spring 21. Alternatively, embodiments can employ a torsional spring 22 mounted about the pivot point 15 and preloaded to induce an initial M_{bias} about the pivot point. Preferably, the position of the pivot point on the motor plate is chosen so as to exploit the fact that the belt strand tensions redistribute when torque is applied to the system. Embodiments employ a geometry such that as torque is applied in a particular direction, belt tension increases proportionally without requiring an additional mechanism.

[0014] Embodiments can also have a second biasing mechanism 30 biasing the second pulley 11 away from the first pulley 10 so that both of the pulleys 10, 11 are tensioned away from each other, but again in a pivoting fashion, as opposed to the linear fashion of the prior art. A mounting plate 31 or the like can be employed between the second pulley 11 and the frame 16 in a fashion similar to that of the motor mount 14. The connection between the mounting plate 31 and the frame 15 is

preferably freely pivotable. A linear spring 32, a torsion spring 33, or the like is preferably employed to provide the bias of the second pulley 11 away from the first pulley 10.

[0015] Embodiments can be used, for example, in marking machines. Embodiments can be used in phase change ink jet marking machines. Embodiments are also suitable for use in electroreprographic, electrophotographic, and electrostatographic marking machines, such as xeroreprographic multifunction copiers/printers.

[0016] In operation, when no torque is applied, a resultant force F_0 of the belt, upon the motor-motor plate assembly, for example, acts along a line of action that is a distance d_0 from the pivot point of the motor plate. The action of the resultant force F_0 at the distance d_0 creates a moment M_0 that is at equilibrium with the moment M_{bias} generated by the biasing element. When torque is applied by the motor, the belt strand-tensions redistribute. As a consequence, the belt-resultant force acts along a new line of action that is a new distance d_1 from the pivot point. Since the moment of the belt-resultant about the pivot must remain constant (that is, equilibrium with M_{bias} must be maintained), this change in moment arm results in a corresponding change in the magnitude of the belt resultant.

[0017] By way of a more general explanation, referring to FIGS. 5 and 6, P represents the pivot point of a motor mounting plate whose positioning with respect to Q, the intersection of belt strands and virtual point of action of belt resultant, can allow one to employ embodiments. The theoretical intersection of the belt-strands "Q" is useful for analysis of the drive. L_x and L_y represent the position of P with respect to Q. F_1 and F_2 are the resultant belt load and are the vector sum of the belt strand tensions under different conditions. F_1 is an initial belt resultant in which no motor torque is applied, while F_2 is the belt resultant with torque applied. F_2 has a different orientation than F_1 because of unequal strand tensions generated by the application of torque.

Each resultant F_1 and F_2 has a moment arm d_1 and d_2 about the pivot point P resulting in a respective moment M_1 and M_2.

[0018] In operation, initially there is no torque applied and a biasing moment M_{bias} is applied to the motor plate via the biasing element, such as a torsional spring at the pivot point or a linear spring attached at d_{bias} from the pivot point. M_{bias} induces an initial tension in the belt strands, the resultant of which is F_1. M_1 must be equal and opposite to M_{bias}. When motor torque is applied, the resultant belt load reorients as F_2, which creates the moment M_2, which must likewise be equal and opposite to M_{bias}. In the exemplary embodiment of FIG. 5, d_2 is less than d_1, which means that F_2 must be greater than F_1, which in turn means that belt load increases when motor torque is applied. By appropriately tuning the pivot point location, greater drive capacity can be achieved, according to embodiments. Note that when a motor torque of opposite sense is applied to the exemplary system of FIG. 5, the belt load, and drive capacity, is reduced. The pulleys need not be of different size to allow application of embodiments, as seen, for example, in FIG. 6. Here, analysis of the moment contributions of the individual belt strands about the pivot point can be done.

[0019] While particular embodiments have been described, alternatives, modifications, variations, improvements, and substantial equivalents that are or may be presently unforeseen may arise to applicants or others skilled in the art. Accordingly, the appended claims as filed and as they may be amended are intended to embrace all such alternatives, modifications variations, improvements, and substantial equivalents.

We Claim: